Specifications for Environmental Control Systems for the City of Seattle

In 1996, at the direction of the Mayors Office and the City Council, City Departments were directed to convene interdepartmental groups to investigate ways the City might gain efficiencies by consolidation of operations or procedures. During those meetings an assessment of building control and operations was done. The assessment demonstrated that the preponderance of building control systems installed in City buildings were the Landis & Staefa System 600, now named Siemens Building Technology Landis 600. Further the system proved to be reliable, had local support, and was easy to operate and maintain.
Due to the wide and successful use of this product it was determined that there were advantages to the City of Seattle by approaching the building control systems from an Citywide rather than a solely Department viewpoint. As a result, an agreement was signed and sent to the Purchasing Department by the Departments participating in the review requesting this system be the City Standard.
A return to this question has produced the same evaluation. Although the previous work was done before the Copernicus project, it was similar in this part of its scope. We suggest that this effort be viewed as an early Copernicus project and be included in the work to gain those efficiencies.

Index

Section 1. Purpose

A. To make known City of Seattle building control systems standard.
B. To set material and construction standards for building control systems for both new construction and renovations.
C. To provide seamless interface between new or modified building control systems and existing systems.
D. To standardize building control performance.
E. To gain the advantage of standardized shared training programs across city departments.
F. To gain the advantage of shared expertise across departments.
G. To gain the advantage of standardized shared inventory.
H. To gain the advantage of an enterprise approach to negotiation for parts and service contracts.
I. To avoid the financial burden to the City of Seattle of supporting service, maintenance, parts and upgrades for multiple control systems.

Section 2. Specifications

A. Furnish and install a complete Building Automation System (BAS) utilizing networked Direct Digital Control (DDC) technology for control and monitoring of the building heating, ventilating and air conditioning systems as described in this specification.

B. System shall consist of stand-alone DDC panels, sensors, automatic valves, actuators, dampers, operating software, operator training, and warranty.

C. The Control Company shall make available program language training to employees of the City of Seattle.

D. The Control Company shall provide all technical data needed to service, maintain, repair, and program the control system to the City of Seattle.

1. The contractor shall provide to the Owner two (2) copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system.

2. The contractor shall instruct the owner's designated representatives in these procedures during the start-up and test period. The instruction shall consist of two separate training components: on-site, project specific training and off-site factory training.

3. On-site training shall consist of a minimum of four (4) full days (32 hours total) of training performed by an engineer familiar with the specific design of the system provided for this project. On-site training shall be separated into an initial two (2) day session that will occur at or prior to building completion and a second two (2) day session that will occur 1-2 months after building completion. The instructions shall consist of both hands-on and classroom training at the jobsite and shall be open to up to owner personnel.

4. An off-site factory training course shall also be provided at the Contractor's factory authorized training center for a minimum of 4 days. This course shall be a regularly scheduled, in depth training course covering general system operating and programming procedures utilizing mechanical equipment simulators similar to the mechanical equipment installed in the owner's facility. Course shall be taught by a factory certified trainer who specializes solely in customer training. A minimum of 3 Continuing Education Units (CEU's) shall be awarded to each training course participant upon completion of training course. This training shall be provided for two (2) employees of the Owner at the manufacturing facility or by the manufacturer's regularly employed trainer(s) at the job site for up to four (4) employees of the Owner. Include all travel and lodging expenses for trainer or owners employees as required.

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5. Provide training materials bound in six (6) manuals for use during all training sessions.

6. Provide one set of the special tools, manuals and test instruments specifically manufactured or modified for or by the system manufacturer for the use by the factory technicians in the instrumentation, troubleshooting, and repairs of installed devices. Include portable test terminals, test boxes, circuits card extenders, calibration modules, etc.

7. Submit shop drawings reflecting final "as-built" condition. Deliver five (5) copies of drawings and AutoCAD Release 14 computer disks. All devices shall be identified with the City of Seattle acronyms shown in the bid documents and unique software identification. (Example: OS12DA; O = Opera House; S = Supply Fan; 12=Fan Designator; DA = Discharge Air.)

8. Provide five (5) copies of reproducible record drawings and computer disks for AutoCAD Release 14. These record drawings shall accurately depict the final as built conditions and shall be on Architectural/Mechanical backgrounds provided by the A/E as computer disks. These drawings shall include accurate depiction of wire runs, including cable identification, conduit size, location of junction boxes, source of power, devices, sensors, controlled equipment (motor starters, valves, Chillers, dampers, AHUs, etc.). All devices shall be identified with the City of Seattle acronyms and unique software identification as described in the above paragraph., The building control system, including all hardware and software components shall be warranted for a period of one year following owner's beneficial use of system. For phased project completion, the warranty shall also commence in phases. Any manufacturing defects arising during this period shall be corrected without cost to the owner.

9. Provide five (5) bound copies of the O&M manuals, describing operation, maintenance and servicing requirements of the HVAC control system and associated equipment. Provide the following information in separate sections each with tab index:

   a) Material list.
   b) Technical literature for all equipment including catalog sheets, calibration, adjustments and operation instruction, and installation instructions, (the operator's instruction portion may be separately bound).
   c) Schematic diagrams of proprietary hardware adequate for repair work down to the component level. (nondisclosure agreements will be signed by the City of Seattle as required).
   d) List of spare parts (with model numbers) recommended for purchase by the owner.
   e) System description and complete sequence of operation.
   f) Reduced size (11 inch by 17 inch) copies of record drawings.
   g) Input/Output (I/O) summary forms for the system listing all connected analog and binary input and output functions and the number type of points.
   h) Control programs specified to this system.
   i) Point to point checkout list used in commissioning.

E. Demonstrated backward compatibility. Backwards compatibility means the system shall have a documented history of backwards compatibility for a minimum of the last 5 years. Future compatibility shall be supported for no less than 10 years. defined as:

   1. The ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.

   2. The ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

F. Local support. Local support means: Manufacturer shall have fully dedicated Service Department facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors that are not factory direct Branch Offices of the control system manufacturer are not acceptable.

G. Standard Manufacture. Standard manufacture means: Materials and equipment shall be the cataloged products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements. These standard components, shall be new, regularly manufactured and not custom designed or fabricated specifically for this project. All components and software shall have been previously tested and proven in regular use.

H. Utilize networked Direct Digital Control (DDC) technology for control and monitoring of the building heating, ventilating and air conditioning systems as described in this specification.

I. Provide open communications system. System shall be capable of utilizing standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols. System shall be capable of BACnet communication according to ASHRAE standard SPC-

135A/95. System shall be capable of OPC server communications according to OPC Data Access 2.0 and Alarms and Events 1.0.

The following BACnet objects and services must be supported by the system.

1. BACnet standard objects, that, at minimum, must be supported by the system:
2. Device
3. Analog Input
4. Analog Output
5. Binary Input
6. Binary Output
7. Notification Class

The following BACnet services must be supported for the system to act as a BACnet server as described below:

a.) For the system to communicate with/on a BACnet network, it must support the following:

BACnet Service	Initi	Execute
Who-Has		X
I-Have	X	
Who-Is		X
I-Am	X	

b.) For the system to allow other BACnet devices to monitor its point values, the system must support the following:

BACnet Service	Initi	Execute
Read Property		X

c.) For the system to allow other BACnet devices to command its point values, the system must support the following:

BACnet Service	Initiate	Execute
Write Property		X

d.) For the system to be able to send alarms to other BACnet devices and receive alarm acknowledgement, the system must support the following:

BACnet Service	Initiate	Execute
Add List Element		X
Remove List Element		X
Acknowledge Alarm		X
Get Alarm Summary		X
Confirmed or Unconfirmed Event	X	

Notification		

e.) If the system will be sending messages to other BACnet devices via COV, it must support the following:

BACnet Service	Initiate	Execute
Subscribe COV		X
Confirmed or Unconfirmed COV Notification	X	

The following BACnet services must be supported for the system to act as a BACnet client as described below:

a.) For the system to communicate with/on a BACnet network, it must support the following:

BACnet Service	Initi	Execute
Who-Has		X
I-Have	X	
Who-Is		X
I-Am	X	

b.) For the system to be able to monitor point values from other BACnet devices, the system must support the following:

BACnet Service	Initi	Execute
Read Property	X	

c.) For the system to be able to command point values in other BACnet devices, the system must support the following:

BACnet Service	Initiate	Execute
Write Property	X	

d.) For the system to be able to receive alarms from points in other BACnet devices, the system must support the following:

BACnet Service	Initiate	Execute
Add List Element	X	
Remove List Element	X	
Acknowledge Alarm	X	
Get Alarm Summary	X	
Confirmed or Unconfirmed Event Notification		X

e.) If the system is capable of receiving BACnet point messages via COV, it must support the following:

BACnet Service	Initiate	Execute
Subscribe COV	X	
Confirmed or Unconfirmed COV Notification		X

J. All system peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX and be so listed at the time of bid.

K. All floor level controllers shall comply, at a minimum, with UL Standard UL 916 category PAZX; Standard UL 864, categories UDTZ and QVAX and be so listed at the time of bid.

L. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

M. The BAS contractor shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

N. The building automation system (BAS) shall conform to the following standard for Year 2000 Compliance:

1. The system shall not produce errors when processing date data (including calculating, sorting or displaying) from, into and between the years 1999 and 2000 and leap year calculations in the year 2000, to the extent that date information provided from other systems, is accurate.

2. The BAS supplier shall provide documentation to support the individual device(s) Year 2000 Compliance. This document shall include a listing of compliance by device and any exceptions to the above definition.

O. The control system must be cable of seamless integration with the existing building control system. Seamless integration means:

The HVAC control system will full functionality and data exchange with the current standard as well as a fully modular architecture, permitting expansion through the addition of more distributed processing units, input/output units, sensors, actuators or operator stations.

P. The design of the BAS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels.

1. A city-wide Management Level Network (MLN) Ethernet network based on TCP/IP protocol.

2. A high performance, peer-to-peer Building Level Network (BLN) and

3. A distributed Floor Level Network (FLN)

Access to all levels of the BAS system architecture shall be totally transparent to the user when accessing data or developing control programs.

The design of BAS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

System shall have the capability to communicate with a BACnet network over Ethernet or BACnet/IP (according to Annex J).

System shall have the capability to be an OLE for Process Control (OPC) Server for dynamic communication with third party systems (OPC Clients) over an Ethernet network. At a minimum, the following must be supported:

a. Data Access
b. Alarms & Events

Q. Energy Management. DDC Controllers shall have the ability to perform any or all the following energy management routines.

a. Time-of-day scheduling
b. Calendar-based scheduling
c. Holiday scheduling
d. Temporary schedule overrides
e. Start-stop time optimization
f. Automatic Daylight Savings Time switchover
g. Night setback control
h. Enthalpy switchover (economizer)
i. Peak demand limiting
j. Temperature-compensated duty cycling
k. Fan speed/cfm control
l. Heating/cooling interlock
m. Cold deck reset
n. Hot deck reset
o. Hot water reset
p. Chilled water reset
q. Condenser water reset
r. Chiller sequencing
s. Prioritize alarm signals in at least 3 levels of criticality

R. The software programs specified in this Section shall be provided as an integral part of DDC controllers and shall not be dependent upon any higher level computer for execution. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Sequence of Operations.

Management Level Network

1. All PCs shall simultaneously direct connect to the Ethernet and Building Level Network without the use of an interposing device

2. Operator Workstation shall be capable of simultaneous direct connection and communication with BACnet, OPC, and Apogee networks without the use of interposing devices.

3. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.

4. When appropriate, any controller residing on the peer to peer building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.

5. Any PC on the Ethernet Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet, as well as, directly connected building level networks. Any PC shall be able to interrogate any controller on the building level network.

6. Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in an alarm notification at the PC.

7. The Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3

8. Access to the system database shall be available from any client workstation on the Management Level Network.

BUILDING LEVEL NETWORK

1. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer BLN. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

2. The peer-to-peer BLN network shall support a minimum of 100 DDC controllers and/or local PC workstations

3. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.

4. Field panels on the BLN must be capable of integration with multiple open standards including Modbus, BACnet, and Lonworks as well as with third party devices via existing vendor protocols.

5. Each PC workstation on the BLN shall support a minimum of 4 peer to peer networks hardwired or dial up.

6. All PC’s on the BLN shall be capable of simultaneously connecting to the Ethernet and Building Level Network without the use of an interposing device

7. Operator Workstations on the BLN shall be capable of simultaneous direct connection and communication with BACnet, OPC, and Apogee networks without the use of interposing devices.

8. When appropriate, any controller residing on the BLN shall connect to Ethernet network via an Ethernet Module.

FLOOR LEVEL NETWORK and APPLICATION SPECIFIC CONTROLLERS (ASC)

1. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASC's) through the Floor Level LAN Device Networks.

2. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Provide the following types of ASC's as a minimum:

   a. UNITARY CONTROLLERS:
   Provide for control of central HVAC systems and equipment including, but not limited to, the following:

   - Rooftop units
   - Packaged air handling units
   - Built-up air handling systems
   - Chilled and condenser water systems
   - Steam and hot water systems

   UC's shall include all point inputs and outputs necessary to perform the specified control sequences. Provide a hand/off/automatic switch for each digital output for manual override capability. Switches shall be mounted either within the controller's key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides. In addition, each switch position shall be supervised in order to inform the system that automatic control has been overridden.

   Each controller shall support its own real-time operating system. Provide a time clock with battery backup to allow for stand-alone operation in the event communication with its DDC Controller is lost and to insure protection during power outages.

   All programs shall be field-customized to meet the user's exact control strategy requirements.

   Programming of UC's shall utilize the same language and code as used by DDC Controllers to maximize system flexibility and ease of use. UC's that utilize a different control language or programming interface software shall not be acceptable and Standalone DDC Controllers shall be provided to meet the specified functionality.

   Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

   The terminal shall provide the user with the following functionality as a minimum:

   - View and set date and time
   - Modify and override time-of-day schedules
   - View points and alarms
   - Monitor points
   - Command and modify setpoints

Should the system controller be unable to interface to a door-mounted terminal, provide a laptop or similar terminal at the controller, or provide a DDC Controller with a door-mounted or local terminal in lieu of the system controller in order to meet the specified minimum functionality.

b. TERMINAL EQUIPMENT CONTROLLERS

Provide for control of each piece of equipment, including, but not limited to, the following:

- Variable Air Volume (VAV) boxes
- Constant Air Volume (CAV) boxes
- Dual Duct Terminal Boxes
- Unit Conditioners
- Heat Pumps
- Unit Ventilators

The Terminal Equipment Controller (TEC) shall interface to the BAS on a LAN communications network originating at the Standalone DDC panel. An individual controller shall be provided for each terminal unit. The terminal controller must be listed by Underwriters Laboratory under UL 916 PAZX and UL 864 UDTZ.

Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, or 0-10vdc allowing for interface to a variety of modulating actuators.

All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable

For VAV boxes, the BAS contractor shall furnish the terminal controller (controller, damper motor, flow transducer) to the terminal unit manufacturer for factory mounting. Costs associated with factory mounting of terminal controller shall be covered by terminal unit manufacturer. The terminal box manufacturer shall provide an averaging air velocity sensor suitable for interfacing with the TEC's differential pressure transducer.

The controller shall include a differential pressure transducer that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual air flow. Single point air velocity sensing is not acceptable. The differential pressure transducer shall have a measurement range of 0 to 4000 fpm (0 to 20.4 m/s) and measurement accuracy of ±5% at 400 to 4000 fpm (2 to 20 m/s), insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified parameters. The BAS contractor shall provide the velocity sensor if required to meet the specified functionality.

Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 cfm air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.

Each TEC shall be accessible for purposes of control and monitoring from a central or remote operator's terminals as specified herein.

TEC damper actuator shall be of the 24 Vac floating point type. Upon power loss, the actuator maintains its current damper position. Position status is shown in percentage open notation.

TEC room temperature sensor shall come complete with a terminal jack and programmable override switch integral to the sensor assembly. The terminal jack shall be used to connect the portable operators terminal to control and monitor all hardware and software points associated with the terminal unit. A terminal jack may be alternatively located on a stainless steel wall plate mounted adjacent to the sensor. An override switch shall initiate override of the night setback or unoccupied mode to normal operation when activated. A thumbwheel-type temperature setpoint dial shall also be provided with 1 Deg F temperature increments. Override switch and temperature setpoint functions may be locked out, canceled or limited as to time or temperature via software.

TEC's for VAV or CV applications shall be provided with integral differential pressure transducer capable of accepting an average air flow measurement signal from the terminal box averaging air velocity sensor. The value is converted through a square root function to average airflow by the TEC.

TEC control valve electronic actuators shall mount on the valve body and provide complete modulating control of the valve. Valve body shall separate from actuator for servicing without requiring any special tools or electrical connections. The actuator shall be of the floating control point type.

TEC wiring terminal bars are to be detachable type allowing quick serviceability of the electronic controller hardware without removal of the existing wiring.

FIELD DEVICES

1. TEMPERATURE SENSORS

All temperature sensors shall be solid state electronic, employing a resistance type output. Room and zone temperature sensors may be thermistor type. All duct sensors shall be rigid or flexible probe, averaging RTD-type sensors. All duct mixed air sensors shall be flexible averaging RTD-type sensors with sensor element length suitable for complete duct coverage. Pipe sensors shall be RTD-type. Provide outside air temperature sensors with watertight inlet fitting and sunlight shield. All single point sensors shall be accurate to a minimum of $\pm$ 0.5 degrees F at 77 degrees F calibration point. Duct averaging sensors shall be accurate to a minimum of $\pm$ 1.0 degrees F.

2. CONTROL DAMPERS

Provide low leakage, galvanized steel control dampers with roll-formed steel frames and blades and oil-impregnated bronze bearings. Dampers shall have blade seals and stops, equal to Ruskin CD36.

Leakage shall be no greater than 10 CFM per square foot at 4 in. W.C. with 20 in.-lbs. torque applied regardless of size.

Provide opposed blade type dampers unless indicated otherwise. All multi-section dampers shall be provided with factory linkage to allow for connection of actuator at one common point.

3. DAMPER ACTUATORS (ELECTRONIC)

Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.

All actuators having more than 100 in-lb torque output shall accept a 1” diameter shaft directly without the need for auxiliary adapters and shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator’s output coupling with the damper shaft.

All actuators shall be designed to withstand a continuous stall condition throughout the full range of rotation without premature failure, or degradation in performance. The actuator shall resume normal operation once the stall condition has been eliminated.

All spring return actuators shall be capable of both clockwise or counterclockwise spring return fail-safe operation and shall use a continuously engaged mechanical return spring that returns the actuator to a fail-safe position in response to a loss of power.

Actuators shall provide a means of manually positioning the output coupling in the absence of power.

Actuators shall not require more than 10VA power draw at any time.

Modulating actuators shall be capable of accepting a 0-10Vdc, 4-20ma or floating point control signal and shall provide an easily readable high contrast position indicator.

All actuators shall be UL873 listed.

4. CONTROL VALVES

Modulating Valves 2" and Smaller: Bronze body and seat with stainless steel stem and screwed ends. ANSI Class 250 body rating. Suitable for fluid temperatures of up to 300 degrees F. Equal percentage flow characteristics capable of smooth operation at differential pressures present in system. Landis & Gyr Powers VE VVG/VXG 44, VE698, Flowrite VE598 or approved equal.

Modulating Valves 2-1/2" and Larger: Cast iron body with bronze trim and stainless steel stem and flanged ends. ANSI Class 125 body rating. Suitable for fluid temperatures of up to 300 degrees F. Equal percentage flow characteristics capable of smooth operation at differential pressures present in system. Landis & Gyr Powers Flowrite VE598 or approved equal.

Sizing: Modulating control valves shall be correctly selected for service and flow of system served. A pressure drop of 5 psi shall be used as a sizing guideline unless specifically noted otherwise in project documents. Two position shutoff valves shall be line size.

5. VALVE ACTUATORS

All modulating valve actuators shall be 24vac electric motor type; floating point, 0-10Vdc, 0-16Vdc or other industry standard input signal type. Actuators shall function properly within the range of 85 to 110 percent of line voltage.

Provide actuators in sufficient size, quantity and type to match application.

All valve actuators for steam applications shall be mounted at a 45 degree offset from vertical to avoid heat damage to actuator.

Actuators shall be spring return as indicated by Normally Closed or Normally Open designation on drawings or in sequence of operation.

6. LOW TEMPERATURE DETECTION THERMOSTATS

Provide low temperature control thermostat, electric type manual reset, non-averaging 20 feet long sensing elements that switch whenever any 6 inch section or more of any portion senses a temperature as low as the thermostat setpoint as specified in sequences.

Provide with two sets of contacts, one for hardwired fan shutdown and one for remote monitoring.

Powers ET141 or approved equal.

7. DIFFERENTIAL PRESSURE SWITCHES

Provide air and liquid differential pressure switches for status of pumps and fans as called out in sequences and input/output summary.

Diaphragm-operated SPDT snap switch with ranges from .05" W.G to 12.0" W.G. for air. Airflow switch shall be Powers SW141 or approved equal.

Liquid switch shall be PENN P74 or equal.

8. CURRENT SENSING RELAYS

Provide current sensing relays for status of fans or pumps as called out in sequences or input/output summary. Provide with field adjustable current setpoint range.

Veris, Nielsen-Kuljian or approved equal.

9. DUCT STATIC OR VELOCITY PRESSURE TRANSMITTERS

Provide integral pressure transducer and transmitter in enclosure suitable for external duct mounting. 4-20ma output proportional to the input pressure span.

Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter.

Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy $\pm$ 1.0% of full scale. Linearity $\pm$ 0.1%. Setra, Ashcroft or approved equal.

10. BUILDING STATIC PRESSURE TRANSMITTERS

Provide integral pressure transducer and transmitter in enclosure suitable for wall or panel mounting. 4-20ma output proportional to the input pressure span.

Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter range shall be unidirectional.

Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy ± 1.0% of full scale. Linearity ± 0.1%. Setra, Ashcroft or approved equal.

11. LIQUID OR STEAM PRESSURE TRANSMITTERS

Provide integral pressure transducer and transmitter in enclosure suitable for exposed mechanical room or panel mounting. 4-20ma output proportional to the input pressure span.

Internal components shall be selected appropriate for the sensed medium taking temperature, pressure, corrosive properties and medium consistency into account.

Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Transmitter shall be rated for a minimum of 125% of maximum expected system operating pressures.

For differential pressure sensing applications, provide transmitter unit with 3-valve manifold to allow unit to be serviced without draining system. For steam applications, provide a coiled tubing loop between the pressure sensing tap and the transmitter.

Each transmitter shall have field adjustable span and zero adjustments for field calibration. Accuracy ± 1.0% of full scale. Linearity ± 0.1%. Ashcroft, Robinson-Halpern, Johnson-Yokogawa, Rosemount or approved equal.

12. STEAM OR LIQUID METERS

Provide a 4-20ma transmitter output linearly scaled to the pressure being sensed. Transmitter range shall be selected so that the normal operating setpoint is midway between the upper and lower range of the transmitter. Infra-red transmitter.

Each transmitter shall have field adjustable span and zero adjustments for field calibration. Transmitter accuracy shall be ± 0.25% of calibrated span including the combined effects of linearity, hysteresis and repeatability. Units shall be provided with a watertight NEMA Type 4 electrical enclosure with ½" NPT conduit connection. Provide Robinson-Halpern, Ashcroft, Johnson-Yokogawa, Rosemount, Niagra, Hersey or approved equal.

For steam applications, provide a coiled tubing loop between the pressure sensing tap and the transmitter.

13. PRESSURE SAFETY SWITCHES

Provide static pressure high limit switches as required by sequence of operation to sensing duct over pressure condition. Provide with adjustable setpoint. Provide with spare contacts for monitoring by DDC system.

Switch shall be suitable for duct mounting. Dwyer Series 3000, Ashcroft or approved equal.

14. CARBON DIOXIDE SENSOR

Provide Non-Dispersive Infra-Red (NDIR) carbon dioxide sensor suitable for room mounting. 4-20ma output signal corresponding to input CO2 concentration.

Range 0-2000 PPM. Accuracy ±3% of full scale. Repeatability ±1% of full scale. Valtronics Model 2089 or approved.

Provide with a complete field calibration kit for initial startup including a CO2 canister.

15. CARBON MONOXIDE SENSOR

Provide single channel, solid-state sensor capable of generating a 4-20ma signal corresponding to carbon monoxide levels of 0-500 PPM. Calibrated for typical CO levels of 50-100 PPM.

Sensing element shall be rated for a minimum of 2 years of service and shall be completely field replaceable.

Suitable for temperature ranges of 32-120 degrees F. Accuracy ± 3% of full scale. repeatability ± 1 % of full scale. QEL, MSA or approved equal.

16. REFRIGERANT DETECTOR

Provide self-contained CFC or HCFC as required refrigerant vapor detector capable of detecting hazardous gas levels. Provide with alarm contacts for 2 separate concentration levels as indicated. Self-contained unit shall also be provided with local audible and visual alarm indication based on preset alarm levels.

Provide QEL model QAS-10128 or approved equal.

17. DUCT AIRFLOW MEASURING STATIONS

Provide as indicated on floor plans for measuring air flow quantities through duct. Station shall consist of multiple insertion-type, Pitot tube probes designed to measure both the static and total pressures of the air in the duct and transmit a differential (velocity) pressure signal. Probes shall be installed across the entire width of the duct.

When more than one probe is required, provide 1/4" copper tube averaging manifolds for both sensing ports.

Accuracy ± 5%. Range 0-2500 FPM, minimum. Air Monitor Voluprobe/VS or approved equal.

18. HUMIDITY SENSORS

Combination sensor/transmitter measuring resistance change through bulk polymer sensor with accuracy at 77 degrees F of ± 2% RH between 20-95% RH including hysteresis, linearity and repeatability.

Output shall be 4-20mA, 2-wire, isolated loop powered, 0-100% linearly proportional.

Provide duct or outside air sensors complete with element guard and mounting plate.

19. DUCT SMOKE DETECTORS

Detectors shall be photoelectric or ionization type for sensing products of combustion within the airstream of ducted fan systems over 2000 cfm. Provide detector with sampling tube extending the width of the duct to provide a complete cross-sectional sampling. Visual indication of trouble or alarm condition shall be provided on the detector housing. An auxiliary set of contacts shall be provided for remote monitoring purposes and the alarm sequence shall comply with the project requirements.

20. INTERPOSING RELAYS

Track mounted SPDT relays (or as required) for all interposing applications.

IDEC or approved equal.

21. LEVEL SWITCHES

Provide single stage displacer-type level switch suitable for mounting at top of tank or sump. Displacer element shall be porcelain or stainless steel and shall slide up and down a stainless steel displacer cable as liquid level fluctuates. Displacer movement above or beyond designated level setpoint(s) shall actuate a pivoted magnet and trip an associated electric switch indicating a high or low level condition.

Provide NEMA 4 switch enclosure for mounting at top of level switch. Provide with flanged or threaded connection as appropriate.

Provide 2 sets of dry contacts within switching enclosure for remote level indication. For applications requiring switching of 120v motors, provide mercury switch suitable for application. Entire unit shall be FM approved.

23. DAMPER END SWITCHES

24. DIGITAL ENERGY MONITORS:

Provide three phase digital watt-meters with pre-wired CTs. All watt-meter electronics shall be housed within the CTs. CTs shall include sizes capable of mounting directly on a power bus. Diagnostics visible to the installing electrician (without a operator tool) shall indicate: proper operation, mis-wiring or low power-factor, device malfunction, and over-load condition. The meters shall include the following:

a. The device shall be UL Listed, and shall comply with ANSI C12.1 accuracy specification. The minimum CT/meter combined accuracy shall be no greater than 1% of reading over the range of 5% to 100% of rated load. The meter shall not require calibration
b. The wattmeter shall directly connect to power from 208 through 480 with no potential transformer. In-line fuses for each voltage tap phase shall be included.
c. The wattmeter CTs shall be split-core and at minimum be sized to accommodate loads ranging from 100 to 2400 Amps. The CTs shall be volt-signal type, and shall not require shorting blocks.
d. The wattmeter shall reside directly on the Floor Level Network along with other FLN devices. Data transferred shall include
    - kW & kWH
    - Consumption
    - Demand
    - Power Factor

- Current
- Voltage
- Apparent Power
- Reactive Power

WORKSTATION OPERATOR INTERFACE

Basic Interface Description

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, 30 character English language point identification, on-line help, and industry standard PC application software. Interface software shall simultaneously communicate with up to 4 Building Level Networks and share data between any of the 4 networks. The software shall provide, as a minimum, the following functionality:

    a) Real-time graphical viewing and control of environment
    b) Scheduling and override of building operations
    c) Collection and analysis of historical data
    d) Point database editing, storage and downloading of controller databases.
    e) Alarm reporting, routing, messaging, and acknowledgment
    f) Display dynamic data trend plot.
        - Must be able to run multiple plots simultaneously
        - Each plot must be capable of supporting 10 pts/plot minimum
        - Must be able to command points directly off dynamic trend plot application.
    g) Definition and construction of dynamic color graphic displays.
    h) Program editing
    i) Transfer trend data to 3rd party software
    j) Scheduling reports
    k) Operator Activity Log
    l) Open communications via OPC Server
    m) Open communications via BACnet Client & Server

2. Provide a graphical user interface, which shall minimize the use of keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.

3. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on a Windows NT 32 bit operating. These Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information.

    a. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows. Operator shall be able to drag and drop information between applications, reducing the number of steps (i.e. Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend).

1. Dynamic color graphics and graphic control

2. Alarm management, routing to designated locations, and customized messages

3. Year in advance event and report scheduling

4. Dynamic trend data definition and presentation

5. Graphic definition and construction

6. Program and point database editing on-line.

b. If the software is unable to display several different types of displays at the same time, the BAS contractor shall provide at least two operator workstations.

c. Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

4. Operator specific password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported).

5. Reports shall be generated on demand or via pre-defined schedule and directed to either CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:

a. A general listing of all or selected points in the network
b. List of all points currently in alarm
c. List of all points currently in override status
d. List of all disabled points
e. List of all points currently locked out
f. List of user accounts and access levels
g. List all weekly schedules
h. List of holiday programming
i. List of limits and deadbands
j. Custom reports from 3rd party software
k. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
l. List of programs

6. Scheduling and override

Provide a calendar type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:

a. Weekly schedules
b. Zone schedules, minimum of 200 unique zones
c. Scheduling for up to 365 days in advance
d. Schedule reports to print at PC.

7. Collection and Analysis of Historical Data

a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

b. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

c. Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of ten points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of 8 true graphs shall run simultaneously. Operator shall be able to command points directly on the trend plot by double clicking on the point.

Dynamic Color Graphic Displays

1. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems and hot water boiler systems, and room level terminal units, shall be provided by the BAS contractor as indicated in the point I/O schedule of this specification to optimize system performance, analysis and speed alarm recognition.

2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of Autocad or scanned pictures for use in the system.

3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to

represent current conditions without operator intervention and without pre-defined screen refresh rates.

a. Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.

b. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.

c. Equipment state can be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.

d. State text for digital points can be defined up to eight characters.

4. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.

5. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

6. Off the shelf graphic software, Microgafx Designer or Corel Draw software shall be provided to allow the user to add, modify or delete system graphic displays.

7. A clipart library of HVAC and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library.

8. A dynamic display of the site specific architecture showing status of controllers, PC workstations and networks shall be provided.

System Configuration & Definition

1. Network wide control strategies shall not be restricted to a single DDC Controller or HVAC Mechanical Equipment controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.

2. Provide automatic backup and restore of all DDC controller and HVAC Mechanical Equipment controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller or HVAC Mechanical Equipment Controller. Changes made at the DDC Controllers or HVAC Mechanical Equipment Controllers shall be automatically uploaded to the workstation, ensuring system continuity.

3. System configuration, programming, editing, graphics generation shall be performed on-line. If programming and system back-up must be done with the PC workstation off-line, the BAS contractor shall provide at least 2 operator workstations.

Alarm Management

1. Alarm Routing shall allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.

2. Alarm Notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons shall be displayed when user is working in other Windows programs. The BAS alarm display screen shall be displayed when the user clicks on the alarm icon.

3. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.

4. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

5. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. Any critical alarms shall have the capability of generating a user defined message and routing that message to any operator device or printer At no time shall the DDC controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

6. For projects with smoke control requirements, the DDC system shall be fully compliant with NFPA guidelines 92A and 92B for smoke control. System hardware shall be UL 864-UUKL listed for smoke control.

Workstation Communications

(Note: 1,1.a and 1.b are optional for use in dial-up applications**)**

1. Provide automatic dial-up communications for buildings as specified. Automatic dial-up communications shall include the following features as a minimum:

    a. Dial-Out

        1) Manual dial-out from the workstation to remote networks shall be accomplishable using only a mouse to select and request the desire remote connection.

b. Dial-In

1) Alarms shall automatically dial into the workstation for display at the terminal and for hard copy printout at the associated event printer.

2) Alarms shall, at the operator's option, dial into a stand-alone modem-printer to provide for real-time alarm printouts even when the workstation is off-line (such as when it is being used to run operator-selected 3rd party software).

3) Trend data shall be scheduled for automatic updating to the workstation at operator-selected times. The operator shall also have the option of manually collecting trend data at any time.

PORTABLE OPERATOR'S TERMINAL (POT)

Industry-standard, commercially available Portable Operator Terminals (POT's) with a LCD display and a full-featured keyboard. The POT shall be handheld and plug directly into all BLN & FLN Controller as described below. Provide a user-friendly, English language-prompted interface for quick access to system information, not codes requiring look-up charts.

Functionality of the portable operator's terminal connected at any Standalone DDC Controller:

1. Access all BLN & FLN Controllers on the network.

2. Backup and/or restore BLN Controller databases for all system panels, not just the Standalone DDC Controller interfaced to the POT.

3. Display all point, selected point and alarm point summaries.

4. Display trending and totalization information.
Add, modify and/or delete any existing or new system point.
Command, change setpoint, enable/disable any system point.
Program and load custom control sequences as well as standard energy management programs.

5 Acknowledge alarms.

Functionality of the portable operator's terminal connected to any FLN Controller:

1. Provide connection capability at either the FLN Controller or a related room sensor to access controller information.
2. Provide status, setup and control reports.
3. Modify, select and store controller database.
4. Command, change setpoint, enable/disable any controller point.

Connection of a POT to a BLN or FLN Controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.

Portable operator terminal access to controller shall be password-controlled. Password protection shall be configurable for each operator based on function, points (designating areas of the facility), and edit/view capability.

Section 3. Procedure for Proposal of an Alternate Product

The City of Seattle is aware that changes in technology can produce improvements in products now is service. The HVAC Review Committee is responsible for keeping City of Seattle building control systems standard in installation and consistent with current technology
Vendors or others may want to submit products they believe are suitable alternatives to the current standard. The following procedure is provided so those vendors of such products can present them to the Review Committee for evaluation and possible inclusion in the City of Seattle Standard.

At no cost to the City of Seattle, vendors may:

A. Contact the City Purchasing Department at 684-4444 and ask for the buyer who manages the product to be submitted for evaluation.

B. Submit specifications to the buyer on the product.

C. The buyer will give the specifications to the HVAC Review Committee along with the vendor's name and contact number.

D. A member of the Review Committee will be assigned to assess the product and establish a suitable test environment.

E. The vendor, with the Review Committee member, will produce a written test procedure. The test procedure will specify:

1. Identity of the product and purpose of the test.
2. An itemized parts list.
3. A drawing of the test installation.
4. A test beginning date and end date.
5. The removal procedure for the test product.

F. The vendor shall supply the material and labor necessary to complete the test installation and removal.

G. The City of Seattle shall assign an appropriate person or persons to assist with the test installation.

H. The Review committee member assigned to the test will produce a written evaluation of the test product.

End of Appendix 3 - A